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OPERATING EXPERIENCE WEEKLY SUMMARY

Office of Nuclear and Facility Safety

May 15 - May 21, 1998

Summary 98-20

Operating Experience Weekly Summary 98-20

May 15 through May 21, 1998

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EVENTS

1. NUCLEAR MATERIAL SAFETY LIMITS VIOLATED AT ROCKY FLATS

On May 5, 1998, at the Rocky Flats Environmental Technology Plutonium Processing and Handling Facility, DOE facility representatives discovered that caustic waste treatment operators violated nuclear material safety limits for height and volume when they heaped moist plutonium precipitate in two glovebox pans. The facility representative notified a criticality safety officer and criticality safety engineers of the violation. The engineers provided the operators with written directions so they could level the pans for geometry concerns. However, when the operators leveled the pans, they did not remove the material from the glovebox, and the criticality volume limit for the glovebox remained violated. The criticality safety officer declared a criticality infraction and posted the glovebox. Criticality safety engineers are developing a recovery plan. DOE facility representatives stated that "operations personnel and managers expressed more concern over the loss of production time than the safety significance of this event." (ORPS Report RFO--KHLL-371OPS-1998-0033)

Investigators determined that criticality safety engineers established the 2-inch depth requirement to maintain the 1.8-liter criticality volume limit for each pan. They determined that the operators heaped the pans so they contained approximately one-and-a-half times the amount allowed for each pan. Investigators determined that the criticality safety evaluation permitted "slight heaping" of the precipitate.

The facility manager held a fact-finding meeting. Meeting attendees learned that "slight heaping" of a pan is permitted only if a corresponding valley exists within the pan. They also determined that the safety evaluation requirement was never intended to allow heaping of one-and-a-half pans of precipitate into one pan. The facility manager directed criticality safety engineers to re-train operations personnel on the correct method of filling the pans. DOE facility representatives stated that during discussions of this event, caustic waste treatment operations personnel demonstrated a very weak understanding of how geometry, volume, and moderation affect criticality.

NFS has reported criticality safety infractions at Rocky Flats in several Weekly Summaries. Following are some examples.

- Weekly Summary 98-19 reported two criticality infractions. Plutonium fabrication operators discovered a non-conservative uncertainty assumption was used to derive criticality safety limits for processing salts, and a criticality safety officer determined that operators failed to control plutonium mass values during bag-out operations. (ORPS Reports RFO--KHLL-PUFAB-1998-0036 AND RFO--KHLL-371OPS-1998-0032)

- Weekly Summary 97-46 reported that a DOE facility representative observing residue-sampling operations noticed that two containers were not stored in designated fixed positions in a storage cabinet, violating criticality spacing requirements. Investigators determined that the residue-sampling team also violated procedures when they opened a drum containing fissionable material without obtaining a criticality safety evaluation or determining criticality safety limits. (ORPS Report RFO--KHLL-371OPS-1997-0096)

- Weekly Summary 96-37 reported that workers moved drums into a storage area with previously infracted drums resulting in a criticality safety violation. Corrective actions included improving communications between operations staff and criticality safety engineers. (ORPS Report RFO--KHLL-771OPS-1996-0148)

These events illustrate the need for personnel to clearly understand criticality safety issues. DOE O 420.1, *Facility Safety*, states that using passive engineered controls (such as geometry control) is the preferred method of control when working with fissile material that could result in criticality safety issues. It also states that when passive controls are not feasible, active engineered controls followed by administrative controls are the preferred order to control fissile material. Double contingency analyses must be performed to justify the chosen controls. When production concerns override criticality safety, violations occur that could lead to serious consequences.

This event also illustrates the importance of writing clear and accurate procedures to eliminate areas of confusion. DOE-STD-1029-92, *DOE Writers Guide for Technical Procedures,* establishes the recommended process for developing technical procedures that are accurate, complete, clear, and consistent. The guide provides guidance for developing a procedure basis; planning, organizing, and structuring the procedure; developing content and establishing format; and writing action steps. DOE and facility managers should review their procedures to ensure they meet the requirements of this standard.

Managers in charge of facilities that contain fissile materials should review the following to ensure that production concerns are aligned with criticality safety requirements and that personnel performing the work are properly trained and understand their responsibilities.

- DOE O 420.1, *Facility Safety*, section 4.3.2, states that nuclear criticality safety programs shall include "operations to ascertain that limits and controls are being followed and that process conditions have not been altered." Section 4.3.3 discusses the application of double contingency and geometry controls.

- DOE O 5480.19, *Guidelines for the Conduct of Operations Requirements for DOE Facilities*, was established to ensure that operations at DOE facilities are managed, organized, and conducted in a manner that ensures an acceptable level of safety. Chapter I, "Operations Organization and Administration," states: "operations activities should recognize that environment, safety, and productivity are compatible goals."

- DOE P 450.4, *Safety Management System Policy*, discusses guiding principles for integrated safety management and states that personnel shall possess the experience, knowledge, skills, and abilities that are necessary to discharge their responsibilities.

KEYWORDS: criticality safety violations, procedures, operations

FUNCTIONAL AREAS: Nuclear/Criticality Safety, Procedures, Management

2. IMPROPER STORAGE OF SCRUB ALLOY MATERIAL

On May 8, 1998, at the Rocky Flats Environmental Technology Site, task team personnel determined that at least 31 containers of scrub alloy material violated the site fire safety requirements for storage and inspection. Site procedures require storing containers that have greater than 50 weight percent of plutonium, and that have not gone through a stabilization process, in inert environments or in areas with heat detector systems. The procedure also requires containers that have not been stabilized to be inspected periodically for oxide formation,

then repackaged. Investigators determined that the containers held greater than 50 weight percent of plutonium, had not undergone stabilization, were not stored in the required environment, and were not in the inspection program. A shift manager restricted entry into the areas where the material is stored and directed facility personnel to post the areas as restricted access. Investigators will determine if a site-wide unreviewed safety question exists. Improper storage of scrub alloy material that is not stabilized is dangerous because it is pyrophoric and can generate hydrogen gas during oxidation. (ORPS Reports RFO--KHLL-371OPS-1998-0037 and RFO--KHLL-SOLIDWST-1998-0009)

Facility managers held a fact-finding meeting. They determined that Defense Nuclear Facilities Safety Board Recommendation 94-1 required Rocky Flats personnel to correctly identify and safely store plutonium-bearing materials and incorporate the necessary requirements into a procedure. However, facility personnel incorrectly assumed that scrub alloy materials contained less than 50 weight percent plutonium, so they incorporated the incorrect requirements for these alloys into the procedure. They also determined that following a similar event on July 23, 1997, facility managers held a fact-finding meeting and directed facility personnel to analyze storage containers to ensure they were properly classified and to sample the containers as necessary. However, those corrective actions did not prevent recurrence.

In 1994, the Defense Nuclear Facilities Safety Board recommended that Rocky Flats expedite processing containers of plutonium-bearing material and convert constituent plutonium to a form suitable for safe interim storage. In mid-1996 a task team incorporated the Board's recommendations into a procedure. In October 1996, facility managers held a fact-finding meeting with criticality safety and material handling personnel to discuss items they believed were not stored in compliance with the procedure. They determined that an exemption (which exempted some materials from the revised procedural requirements for up to a year) was incorrectly incorporated into the procedure. Facility managers determined that the procedure revision should be further modified to allow building managers one year to implement plans and stabilize legacy plutonium-bearing materials. Investigators determined that the building managers did not complete implementation of the plan.

NFS reported the July 1997 and the October 1996 events at Rocky Flats in Weekly Summaries 97-31 and 96-43. Following are summaries of each.

- Weekly Summary 97-31 reported that task team personnel determined that ten containers of plutonium residue violated the site fire safety procedure for storage of plutonium. The procedure required containers to be stored in inert environments or in areas with heat detector systems if they had not been stabilized. The two containers had not undergone stabilization and were not stored in the required environment. (ORPS Report RFO--KHLL-371OPS-1997-0060)

- Weekly Summary 96-43 reported that a building operations manager determined that 11 cans of plutonium oxide were stored in a manner that violated a new procedure requirement limiting their storage to 1 year or less. The cans had been stored for more than 4 years. On October 17, 1996, nuclear material control personnel notified a shift manager that a container of plutonium oxide material stored in a vault since 1991 violated the same requirement. (ORPS Reports RFO--KHLL-771OPS-1996-0166 and RFO--KHLL-371OPS-1996-0136)

Many containers of plutonium-bearing materials classified as "residuals" are stored at Rocky Flats, and some of these materials are potentially chemically unstable. Many of the containers also hold plutonium metal that is in contact with, or in proximity to, plastic. The Defense Nuclear Facilities Safety Board recommended repackaging the plutonium in accordance with DOE-STD-3013-94, *Criteria for Packaging of Plutonium Metals and Oxides for Long-Term Storage*, to eliminate existing hazards. The Board stated (in Recommendation 94-1) that

"additional delays in stabilizing these materials will be accompanied by further deterioration of safety and unnecessary increased risks to workers and the public."

These events emphasize the importance of taking timely and effective corrective actions. DOE contractors who operate nuclear facilities and fail to implement corrective actions for identified deficiencies could be subjected to Price-Anderson civil penalties under the work processes and quality improvement provisions of 10 CFR 830.120, *Quality Assurance Requirements.* These actions include Notices of Violation and, where appropriate, non-reimbursable civil penalties. The primary consideration for determining whether DOE takes enforcement action is the actual or potential safety significance of the violation, coupled with how quickly the contractor acts to identify and correct problems. DOE STD-7501-95, *Development of DOE Lessons Learned Programs*, discusses management's responsibility for incorporating appropriate corrective actions in a timely manner.

DOE-STD-3013-96, *Criteria for Preparing and Packaging Plutonium Metals and Oxides for Long-Term Storage*, establishes safety criteria for packaging of plutonium metals and stabilized oxides for long-term storage.

DOE-HDBK-1081-94, *Primer on Spontaneous Heating and Pyrophoricity*, provides information on properties, storage and handling, process hazards, and fire extinguishing methods for combustible metals. Plutonium reacts at an accelerated oxidation rate when heated to its ignition temperature. Finely divided metal and turnings ignite readily and achieve a high initial temperature that lasts until melting occurs and the surface is reduced. Many plutonium fires have occurred because samples containing finely divided metal spontaneously ignited. Plutonium fires should not be approached without protective clothing and respirators unless the fire is enclosed in a glove box. The most effective agent for extinguishing plutonium fires is magnesium oxide sand. Using water to extinguish the fire is acceptable if criticality safety considerations are not a concern.

KEYWORDS: fire protection, storage, combustible

FUNCTIONAL AREAS: Fire Protection, Materials Handling/Storage

3. WORKERS EXPOSED TO TOXIC GAS LEAK

On May 5, 1998, at a Weldon Spring Site Remedial Action Project hazardous material storage shed, two workers were exposed to an anhydrous hydrofluoric acid mist when they disconnected sample tubing from a compressed gas cylinder. The workers had entered the shed to inspect the cylinder and remove a piece of tubing. When they entered the shed, they smelled a metallic odor, but they still proceeded to remove the tubing. As they were removing the tubing they observed a white mist. They immediately stopped work, exited the shed, and made the proper notifications. Project personnel performed colorimetric detector tube testing in the general area of the cylinder and detected a maximum of 15 ppm of hydrofluoric acid. The American Conference of Governmental Industrial Hygienists concentration limit for hydrogen fluoride is a 3 ppm ceiling limit, and the "immediate danger to life or health" concentration limit is 30 ppm. Facility personnel reported that the workers did not experience any adverse effects from the exposure. (ORPS Report ORO--MK-WSSRAP-1998-0012)

Workers had removed nine uncharacterized cylinders during remediation of various site areas and had placed them in a temporary storage location pending characterization and disposal as part of site decontamination and decommissioning activities. Project personnel believed that the cylinders might contain a corrosive oxidizer, such as anhydrous hydrofluoric acid, fluorine, or chlorine trifluoride. Because of the potential for extremely toxic contents, project personnel implemented sampling work controls that included using an approved work plan, establishing an exclusion zone, and using self-contained breathing apparatus.

Investigators determined that on May 2, 1998, the two workers, using the approved plan, opened seven of the cylinders to collect samples and observed no discharges. However, when they opened the eighth cylinder, they observed a gas release that caused an orange glow in the sampling tubing followed by combustion of the collection bag. They closed the cylinder valves and exited the area. Facility managers suspended the sampling activities, initiated an investigation, and directed workers to move the cylinder into a hazardous material storage shed. Three days later, the two workers entered the storage shed to retrieve the sampling tubing for analysis. They used an approved task-specific safety assessment that did not require respiratory protection because facility personnel believed that both valves on the cylinder had been fully closed and no leaks would occur.

NFS has reported events in past Weekly Summaries concerning unexpected encounters with, and releases of, toxic substances during the performance of activities in support of decontamination and decommissioning, remedial actions, and plant operations. Following are some examples.

- Weekly Summary 93-15 reported that two technicians at the Los Alamos National Laboratory Plutonium Process and Handling Facility accidentally released tritium gas when they removed the contents of a drum and dropped an oil can onto a manifold that connected two small cylinders of 827 mCi tritium-argon gas. One worker received an internal dose of 26 mrem and the other received an internal dose of 13 mrem. Approximately 600 mCi of tritium were released to the environment. (ORPS Report ALO-LA-LANL-TA55-1993-0009)

- Weekly Summary 95-44 reported that a hydrogen flash fire occurred when a subcontractor at the Fernald Environmental Project cut a 1-inch metal pipe with a portable electric band saw during decontamination and demolition. The subcontractor was removing piping associated with an anhydrous hydrofluoric acid system that had been shut down since 1988. Heat generated by the saw caused a rapid exothermic reaction of gas that resulted in the fire. Investigators believed that the subcontractor assumed there would be no hydrogen because the lines had been open to the atmosphere and the system had been shut down for years. (ORPS Report OH-FN-FERM-FEMP-1995-0122)

- Weekly Summary 93-36 reported that three workers at the Los Alamos National Laboratory received internal plutonium contamination while preparing equipment for decontamination and decommissioning at the Plutonium Process and Handling Facility. The three workers had positive nasal smears ranging from 27 dpm to 309 dpm. Facility personnel suspect the source of the contamination was residual plutonium fluoride gas in a depressurized argon line to a glovebox. The gas was released when a technician loosened a bolt that was common to the electrical equipment and a block valve in the gas line, dislodging the valve. The technician was wearing standard personnel protection clothing, surgical gloves, and booties. (ORPS Report ALO-LA-LANL-TA55-1993-0033)

- Weekly Summary 92-24 reported that two maintenance workers at the Paducah Gaseous Diffusion Plant were exposed to hydrogen fluoride while conducting post-maintenance tests on a compressor. The workers experienced eye and throat discomfort and quickly left the area. A colorimetric detector tube test for detecting hydrogen fluoride revealed hydrogen fluoride levels of 60 ppm to 80 ppm in the work area. Failure to properly reconnect instrument lines to a process seal system caused the hydrogen fluoride leak. (ORPS 10-Day Report ORO--MMES-PGDOPERD-1992-0062 and Daily Operations Brief dated 10/07/92)

These events underscore the importance of using effective work control practices and job planning processes to address potential hazards of performing activities with uncharacterized materials and higher-than-normal potential for personnel exposures or contamination. Controls and plans should reflect the importance of ensuring that systems containing toxic materials are isolated properly after they have been operated. The controls and plans should also reflect the importance of wearing personal protective equipment, including self-contained breathing apparatus appropriate for worst-case exposures, when working in areas containing toxic substances. The May event at Weldon Spring Site is significant because unanticipated conditions occurred on two separate occasions involving one of the uncharacterized gas cylinders. The chemical reaction occurred as a result of using sample equipment that was incompatible with the compressed gas being sampled, and the leak occurred when workers were conducting an activity that did not require the use of personal protective equipment for protection against the material contained in the cylinder.

Managers and supervisors in charge of job performance should ensure that hazards associated with decontamination and decommissioning, remediation, and facility operations, are identified and included in the appropriate procedure steps and precautionary statements. DOE facility managers should ensure that personnel understand the basics of work control practices and safety and health hazard analyses. Requirements and guidance for worker protection can be found in the following references.

- DOE 0 440.1, *Worker Protection Management for DOE Federal and Contractor Employees*, states that the contractor must identify workplace hazards and evaluate the risk of associated worker injury or illness.

- DOE/EM-0142P, *Decommissioning Handbook*, DOE Office of Environmental Restoration, March 1994, provides requirements for worker protection during decontamination and decommissioning activities. Section 12 states that worker protection is an important element of any project. The handbook divides worker protection issues into three categories: (1) protection from radiation; (2) protection from toxic and hazardous materials; and (3) protection from traditional industrial safety hazards. The handbook further states that DOE decommissioning activities may combine hazards not commonly encountered elsewhere (such as industrial safety hazards and radiological hazards) and lists OSHA regulations that apply to decommissioning, as well as key elements of a health and safety program. Section 12 of the handbook also states that extra precautions are required for worker safety because hazards in the facility may be unknown and many activities are infrequently performed.

- The *Hazard and Barrier Analysis Guide*, developed by OEAF, discusses barriers that provide controls over job hazards. The guide provides a detailed analysis for selecting optimum barriers, including a matrix that displays the effectiveness of different barriers in protecting against some common hazards. A copy of the *Hazard and Barrier Analysis Guide* is available at URL http://tis.eh.doe.gov:80/web/oeaf/tools/hazbar.pdf.

- National Research Council Publication ISBN 0-309-05229-7, *Prudent Practices in the Laboratory: Handling and Disposal of Chemicals*, 1995, discusses good chemical handling practices for a laboratory setting that can be applied in other work settings. Chapter 6, section D, discusses safe practices for working with hazardous compressed gases. Chapter 7 discusses practices for characterizing, storing, and disposing of hazardous waste. Appendix B contains laboratory chemical safety summaries for 88 commonly encountered hazardous substances.

The publication may be obtained by contacting the National Academy Press at 2101 Constitution Avenue, N.W., Washington, D.C.

Chemical safety information is also available on the DOE Office of Environment, Safety and Health, Office of Worker Safety, Chemical Safety Program Home Page. The home page (located at URL http://tis.eh.doe.gov:80/web/chem_safety/) provides links to many sources of information, including requirements and guidelines, lessons learned, chemical safety networking, and chemical safety tools. Material safety data sheets are available from the Vermont Safety Information Research Institute at URL http://siri.org/msds or from Cornell University at URL http://msds.pdc.cornell.edu/issearch/msdssrch.htm. Chemical safety and personal protective equipment information is available on the National Institute for Occupational Safety and Health Home Page at URL http://www.cdc.gov/niosh.

KEYWORDS: compressed gas, job-hazard analysis, work planning, toxic materials

FUNCTIONAL AREAS: Chemistry, Industrial Safety, Hazards and Barrier Analysis, Materials Handling/Storage, Work Planning

4. PHOSPHORUS CONTAMINATION

On May 15, 1998, at Lawrence Berkeley Laboratory, a researcher was contaminated when he spilled phosphorus in a laboratory. The researcher then spread the contamination in the laboratory room and in an adjoining hallway. Radiation control technicians detected approximately 3 million dpm on the researcher's shoes, 130,000 dpm on his lab coat, and 220,000 dpm on the floor. They also detected 8,000 dpm on a radiation control technician's shoes. Radiation control technicians decontaminated the researcher, the radiation control technician's shoes, the hallway, and non-radiological areas in the laboratory. However, they were unable to complete decontamination of the floor in the radiological area of the laboratory, so they taped the contaminated areas and secured them until further decontamination can be completed. Phosphorus is a beta emitter with a 14 day half-life. Failure to follow procedures resulted in personnel contamination and the spread of contamination throughout the work area. (ORPS Report SAN--LBL-LSD-1998-0001)

Investigators determined that the phosphorus was partially frozen. They also determined that the researcher used a pipette tip to break the phosphorus apart and a piece of phosphorous broke off, fell, and landed on the laboratory floor. The researcher attempted to clean the floor by placing an absorbent towel on it and using his foot to wipe it, but he was unable to clean up the spill. He surveyed his hands and lab coat and found no contamination, so he left the radiological area to call for assistance and waited in the hallway for responders.

The facility manager directed facility personnel to perform an investigation of the event. Investigators determined that the procedure for working with phosphorus requires it to be thawed completely before use. They determined that the researcher did not follow the procedure because it was late in the day and he believed he could easily separate the partially frozen material. Investigators believe that the radiation control technician may have contaminated his shoes when he walked through an area of the hallway where the researcher had walked. They determined that no other personnel in the area were contaminated. Radiation control technicians will continue to decontaminate the area or continue to restrict the area until the phosphorous has decayed.

NFS has reported events in which failure to follow procedures resulted in the spread of contamination in several Weekly Summaries. Following are some examples.

- Weekly Summary 97-10 reported that a researcher at the Lawrence Berkeley National Laboratory spilled a small amount of orthosphosphate phosphorus while opening a vial. The spill resulted in skin, clothing, and internal contamination of the researcher and contamination to the clothing of two other people. The surrounding area and equipment were also contaminated. The work was being conducted in a laminar-flow biohood in a laboratory room. Neither the biohood nor the room was authorized for the radioisotope work. The activity of the radioisotope was ten times the authorized amount for the laboratory, and the chemical form was not authorized. Bioassay (urine) testing confirmed that the researcher received an uptake of 0.15 microrem. (ORPS Report SAN--LBL-LSD-1997-0002)

- Weekly Summary 94-47 reported two contamination events at the Lawrence Berkeley Laboratory. The first event involved an individual who spilled radioactive phosphorous on his clothing and carried it off-site. The second event involved an individual who traveled off-site with radioactive sulfur-35 on his shoe. The spread of contamination was limited to the clothing and shoes in each event. (ORPS Reports SAN--LBL-LSD-1994-0004 and SAN--LBL-LSD-1994-0005)

OEAF engineers searched the ORPS database for events with a nature of occurrence of procedure violation and the spread of contamination or personnel contamination from January 1990 to present and found 90 occurrences. Figure 4-1 shows the distribution of root causes for these events. A review of these occurrences shows that managers reported 43 percent of the root causes as management problems and 36 percent as personnel errors. Further review of the management problems shows that 44 percent were reported as inadequate administrative control, and 28 percent were reported as policy not adequately defined, disseminated, or enforced. Further review of the personnel errors shows that 69 percent were reported as inattention to detail. In addition, OEAF engineers reviewed all 90 occurrences and determined that managers attributed 13 percent of these events to laboratory personnel (professors, researchers, or experimenters).

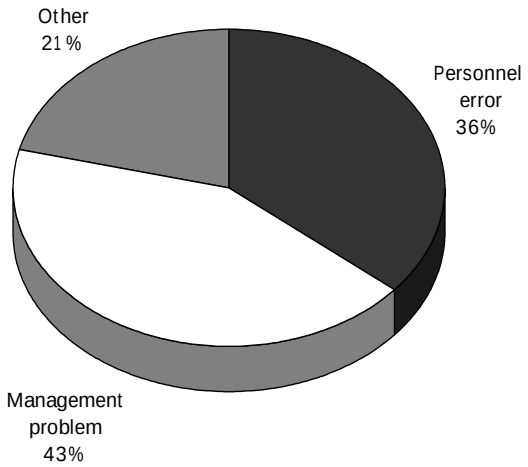

Figure 4-1. Root Causes for Procedure Violations that Resulted in the Spread of Contamination[1]

[1] OEAF engineers searched the ORPS database using the graphical user interface for reports with a nature of occurrence code of "1F" (violation/inadequate procedures) AND "1D" (loss of control of radioactive material/spread contamination) OR "4B" (personnel contamination) from January 1990 to present and found 90 events.

This event is significant because failure to follow procedures resulted in the spread of contamination. This event could have been avoided if the researcher had let the material thaw. Laboratory personnel, including new hires, students, post-graduate students, and the like, should be able to demonstrate their proficiency with safe laboratory practices and their knowledge of laboratory procedures. Managers and supervisors must strictly enforce laboratory policies and procedures to prevent personnel injuries and contamination.

- DOE/EH-0256T, *U.S. Department of Energy Radiological Control Manual*, provides direction for controlling radioactive materials. Section 123, "Worker Responsibilities," states that trained personnel should recognize that their actions directly affect contamination control, personnel radiation exposure, and the overall radiological environment associated with their work.

- U.S. National Research Council publication ISBN 0-309-05229-7, *Prudent Practices in the Laboratory: Handling and Disposal of Chemicals,* 1995, states: "While the experiments may be prepared and conducted by the laboratory workers, it remains the responsibility of the laboratory supervisor to determine what level of experiment planning is appropriate and to be accountable for necessary training, documentation, and compliance with regulations."

- 29 CFR 1910.1450, *Occupational Exposure to Hazardous Chemicals in Laboratories*, provides direction on using chemicals and includes information about signs and labels, spills and accidents, basic rules and procedures, and training and information.

- DOE/EH-0420, Safety Notice 94-03, "Events Involving Undetected Spread of Contamination," provides guidance, good practices, and corrective actions to prevent the spread of contamination. Safety Notice 94-03 can be obtained by contacting the ES&H Information Center, (800) 473-4375, or by writing to U.S. Department of Energy, ES&H Information Center, EH-72, 19901 Germantown Road, Germantown, MD 20874. It can also be found on the Internet at URL http://tis.eh.doe.gov:80/web/oeaf/tools/hazbar.pdf.

KEYWORDS: laboratory, spill, contamination, procedures

FUNCTIONAL AREAS: radiation protection, chemistry, procedures

5. LEAK DETECTORS FAIL TO MEET IGNITION SOURCE CONTROL REQUIREMENTS

On May 8, 1998, at the Hanford Site Tank Farms, a Flammable Gas Evaluation Advisory Board determined that catch-tank leak detectors might not be in compliance with basis for interim operations controls. On May 10, 1998, unreviewed safety question screeners determined that the leak detectors did not meet requirements identified in technical safety requirements for leak detectors to meet National Fire Protection Association Class I, Division 2, Group B, requirements for ignition sources located in potentially flammable environments. Failure of equipment to meet National Fire Protection Association requirements for ignition sources increases the chance for fire or explosions. (ORPS Report RL--PHMC-TANKFARM-1998-0049)

A Class I, Division 2, location is a location (1) in which volatile flammable liquids or flammable gases are handled, processed, or used, but in which the liquids, vapors, or gases will normally be confined within closed containers or closed systems from which they can escape only in case of accidental rupture or breakdown of such containers or systems, or in case of abnormal operation

of equipment; (2) in which ignitable concentrations of gases or vapors are normally prevented by positive mechanical ventilation, and which might become hazardous through failure or abnormal operation of the ventilating equipment; or (3) that is adjacent to a Class I, Division 1, location, and to which ignitable concentrations of gases or vapors might occasionally be communicated unless such communication is prevented by adequate positive-pressure ventilation from a source of clean air, and effective safeguards against ventilation failure are provided. Group B atmospheres contain hydrogen, fuel, and combustible process gases containing more than 30 percent hydrogen by volume or gases or vapors of equivalent hazard (such as butadiene, ethylene oxide, propylene oxide, and acrolein).

Investigators determined that before the basis for interim operation was implemented in September 1997, facility safety documentation developers did not evaluate the hazards of not using intrinsically safe instruments in the catch tank pump pits. The operating contractor misinterpreted a temporary exemption to the technical safety requirement as meaning that he could continue to operate the leak detectors. However, the intent of the temporary exemption was to allow continued transfers with the detectors turned off. When the facility manager was informed of the decision of the Flammable Gas Equipment Advisory Board, he directed that the leak detectors be de-energized and that compensatory measures be implemented until the detectors can be replaced.

OEAF engineers reviewed the ORPS database for similar occurrences involving inadequate control of ignition sources and found the following occurrences.

- On August 13, 1997, at the Hanford Site Tank Farms, the Flammable Gas Evaluation Advisory Board could not verify that flammable gas monitors installed with saltwell pumping equipment met ignition source controls identified in facility safety requirements. The tank farms operations manager shut down saltwell pumping transfers until the installed monitors could be replaced with monitors that met National Fire Protection Association requirements for Class I, Division 2, Group B, locations. (ORPS Report RL--PHMC-TANKFARM-1997-0066)

- On February 26, 1997, at the Hanford Site Waste Sampling and Characterization Facility, an engineer performing a work package walk-down discovered that raceway conduit fittings associated with a lighting system did not meet National Fire Protection Association requirements for Class I, Division 2, Groups A, B, and D. The workers isolated power to the lighting system, removed flammable gas cylinders, and replaced conduit fittings with fittings that met National Fire Protection Association requirements. (ORPS Report RL--PHMC-WSCF-1997-0002)

- On May 8, 1991, at the Oak Ridge K-25 Incinerator Facility, investigators discovered that pressure differential switches and level indicators did not meet National Fire Protection Association requirements for instruments located in flammable environments. The pressure switches did not meet requirements because conduit seals were not installed when the instruments were replaced. The level indicators did not meet requirements because they were not explosion-proof.

These events underscore the importance of having administrative controls in place to ensure proper selection and installation of equipment in hazardous locations. Facility managers need to review their facilities to ensure that all fire protection standards are met and that equipment in flammable or explosive environments is constructed of spark-resistant material or is rendered incapable of sparking. Managers also need to ensure that installed equipment is evaluated when safety documentation changes the requirements for that equipment. Managers responsible for fire protection, equipment selection, and installation should review the following references.

- National Fire Protection Association, *NFPA 70 – National Electrical Code*, Article 500, "Hazardous Locations," covers the requirements for electrical and electronic equipment and wiring for all voltages in locations where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers or flyings.

- American National Standards Institute, ANSI/UL 913, *Standard for Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1 Hazardous Locations*, provides construction and performance requirements for intrinsically safe equipment.

Ordering information for NFPA documents can be found at the NFPA Home Page located at URL http://www.nfpa.org. DOE fire protection references can be found at the DOE Fire Protection Home Page at URL http://nattie.eh.doe.gov:80/fire/directives.html. Ordering information for ANSI documents can be obtained at the ANSI Catalogs and Standards Information Home Page located at URL http://web.ansi.org/public/std_info.html.

KEYWORDS: fire protection, explosive, hazard analysis, safety analysis

FUNCTIONAL AREAS: Explosive Safety, Fire Protection

6. FOOD PREPARATION OVEN USED AS A RESEARCH OVEN

On May 14, 1998, at the Hanford Site Pacific Northwest National Laboratory, a research and development staff member used an electric food preparation oven located in a common-space lunchroom as a research oven and left it unattended. The staff member placed an apparatus in the oven to cure gasket materials, set the oven to the self-cleaning cycle, and left for the day. A project manager observed a haze and smelled smoke in the vicinity of the oven and discovered the apparatus heating in the oven. Use of food preparation ovens for other than their intended purpose can result in equipment and facility damage and in personnel injuries. (ORPS Report RL--PNNL-PNNLBOPER-1998-0005)

Investigators determined that the haze and smell of smoke were products of food residues exposed to high temperatures during the self-cleaning mode. They also determined that the potential for fire or personnel exposure to hazardous materials was extremely low because of the small quantities of polymeric gasket material in the apparatus being cured in the oven. When the project manager discovered the apparatus heating in the oven, she turned off power to the oven, allowed the apparatus to cool, and removed it from the oven. The research and development staff member left a note on the project manager's office chair before leaving for the day, but the project manager discovered the improper use of the oven before she returned to her office. The project manager informed the research and development staff member that he had violated laboratory policy and the Facility Use Agreement. These documents indicate that Laboratory staff are responsible for using lunchrooms and equipment located therein only for food preparation.

NFS reported incorrect use of heating devices in several Weekly Summaries. Following are some examples.

- Weekly Summary 97-36 reported that a small fire occurred in an electric oven located in a radiologically controlled area at the Los Alamos National Laboratory Chemistry and Metallurgy Research Facility. A Health Physics Operations staff assistant and a Health Physics Measurements technician used the oven to dry and ash a cotton mop-head. At the end of the day, the technician reduced the oven temperature and left it operating unattended over the weekend. When the

technician entered the room after the weekend, he saw light smoke coming from the oven vent and sides. He turned the oven off and notified his supervisor. (ORPS Report ALO-LA-LANL-CMR-1997-0016)

- Weekly Summary 97-24 reported that a laboratory technician at the Weldon Spring Site received an electrical shock and burned her right hand when she turned on a hair dryer used to dry soil samples. She dropped the dryer when she felt the shock and saw sparks. Another technician observed the incident and unplugged the dryer. The hair dryer was a home-use type rated at 1,250 watts (125 volts). Investigators determined that use of the consumer grade hair dryer had not been authorized by the Safety Department. (ORPS Report ORO--MK-WSSRAP-1997-0006)

- Weekly Summary 96-44 reported that an unattended electric bake-off oven in a laboratory at the Savannah River Site caught fire when it overheated because a temperature controller failed. The oven was used for heating, drying, and evacuating materials. A laboratory technician did not follow procedures that required notifying control room personnel of the unattended experiment and providing instructions for emergency shut-down of the oven. (ORPS Report SR--WSRC-LTA-1996-0036)

These events underscore the hazards of unattended operation of heating devices and using heating devices for other than their intended purpose. Experimenters need to ensure that unattended laboratory heating devices are designed to be fail-safe and that other organizations are aware of the operation, hazards involved, emergency actions, and responsible contacts before the device is allowed to operate unattended. Inappropriate use of consumer grade equipment and tools in the industrial working environment can result in equipment failure and personnel injury.

U.S. National Research Council publication ISBN 0-309-05229-7, *Prudent Practices in the Laboratory: Handling and Disposal of Chemicals,* 1995, states that laboratory ovens, as well as other laboratory heating devices, are constructed to minimize the risk of electric shock and of accidentally producing an electrical spark or other ignition source. Laboratory ovens are constructed such that their heating elements and their temperature controls are physically separated from their interior atmospheres. Household appliances generally do not meet these criteria and should not be used for laboratory work. Similarly, laboratory ovens should never be used for human food preparation.

KEYWORDS: fire safety, laboratory, oven,

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